THE ENGINEER.

The British Industries Fair at Birmingham.

The British Industries Fair, Birmingham.

FOLLOWING our usual custom, we describe in this Supplement some of the exhibits possessing direct engineering interest at the Birmingham section of the British Industries Fair, which will be opened on February 22nd and will close on March 4th. This account will be continued in future issues of THE ENGINEER.

As we have already announced, the Fair buildings at Castle Bromwich have again been extended by the addition of another 40,000 square feet of floor space, and they now cover an area of approximately 13 acres. In addition, the outdoor exhibits will be more extensive, and will include a demonstration road, 60ft. wide by 1500ft. long, which will be constructed during the progress of the Fair. All kinds of modern machinery will be used in the work, and the road will be provided with electric light and traffic signals.

A very welcome addition to the amenities of the place will be the new properly made road encircling the buildings. On this road there will run continuously a circular service of motor coaches, and entry turnstiles will be provided to each of the principal sections. In this way visitors who wish to see only one part of the Fair will be relieved of the tramp down the passages, past stands that might not interest them, which, in the past, could extend to a third of a mile.

Inside the Fair buildings there will be found three new sections — plant for Public Works, Quarries, and Roads; equipment for the Industrial use of Oil Fuel; and Cycles and Motor Cycles, in each of which sections there are interesting exhibits by representative manufacturers.

MOLER PRODUCTS, LTD.

Some little time ago we published a description of the works of Moler Products, Ltd., 42, Kingsway, London, W.C. 2, and explained the merits of the heat insulating materials manufactured there, so it will not be necessary to enlarge to any great extent on the exhibits of this company at the Fair. The stand, which is to occupy the same position as it did last year, is to include a gas-fired furnace, which will be worked at a temperature of about 1000 deg. Cent.; but, on account of the high heat insulating qualities of the Fosalsil bricks with which it is encased, it is anticipated that no inconvenience will be experienced by visitors on account of the continuous operation of this high-temperature furnace. A more recent addition to the products of this company is Fosalsil insulating concrete. It is a mixture of calcined diatomaceous earth with ordinary Portland cement, in the proportion of about five to one. The Fosalsil is soaked in water overnight and the surplus water then drained off. The Portland cement is then added and the whole thoroughly mixed into a somewhat dry, crumbly consistency, rather than the plastic mix of ordinary concrete. The concrete is then thoroughly rammed in position, covered with wet sacking for about forty-eight hours and then allowed, say, ten days for curing. Slabs thus made can be safely subjected to temperatures as high as 1050 deg. Cent., while they have the high heat insulating qualities of the diatomaceous earth, of which they are principally composed.

THE BRYAN DONKIN COMPANY, LTD.

ON the stand of the Bryan Donkin Company, Ltd., of Chesterfield, there will be a large number of photographs and models illustrative of the appliances which this company provides for the gas-making industries. There will also be the impeller—illustrated in Fig. 1—from a high-speed turbo-exhauster of the Rateau type—a form of machine which this company has recently introduced into this country. The peculiarity of these machines lies in the very high speed at which they are run, so that a large difference in pressure can be obtained with a single impeller. The speed, naturally, depends upon the circumstances, but may range from 10,000 r.p.m. upwards. It is thus possible to produce a pressure difference in one stage, which, with the usual cellular form of construction and normal speed, would require three or four stages. These high speeds are made feasible by machining the impeller out of a solid piece of high tensile steel and forming the vanes radially, or almost so, as is shown in the engraving. Great care is taken to see that the vanes are evenly pitched and of uniform thickness at equal radii in order to ensure a perfect balance. Where the shaft protrudes from the casing a stuffing-box of the labyrinth, or carbon ring, type is provided, while, sometimes, a combination of the two designs is adopted.

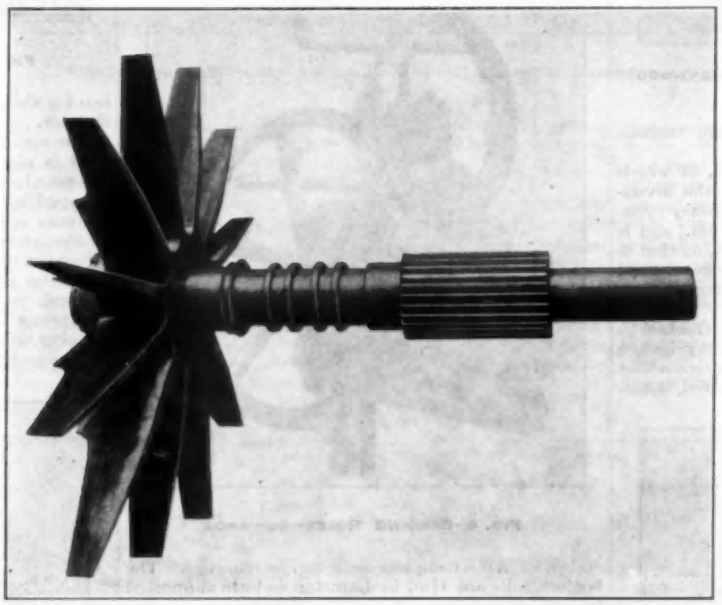


FIG. 1—IMPELLER OF HIGH-SPEED EXHAUSTER—BRYAN DONKIN

In machines of the single-inlet type the casing is usually in halves with a horizontal joint and with the delivery branch arranged on the lower half. The suction branch is on the centre line with the intake "stream-lined," so as to reduce resistance as much as possible. In double-inlet machines both the suction and delivery branches are usually fixed on the lower half of the casing.

By the adoption of these machines the saving in floor space is considerable, and the weight and cost of foundations are reduced in proportion. In the case of turbine drives the high speed of rotation results in a considerable saving in steam consumption as compared with turbines having the same number of stages and running at lower speeds. For electric motor drives a speed-increasing gear between the exhauster and motor is usually necessary, as is indicated by the spur wheel on the shaft of the impeller which we illustrate.

The other appliances to be represented on this stand are in the nature of valves for controlling gas mains, in which the bonnet can be removed and a new nut or spindle inserted while the valve is under pressure; pressure regulators, gas governors, and reciprocating gas compressors.

IMPERIAL CHEMICAL INDUSTRIES.

Imperial Chemical Industries, of Millbank, London, S.W. 1, will have several stands at the Fair, but probably the most impressive will be that of a model house which is intended to demonstrate both the utility and decorative effect which can be obtained with modern forms of non-ferrous metals. The I.C.I. claims to be the largest manufacturer of non-ferrous metals in Great Britain, and will show specimens of brass, copper, cupro-nickel, bronze, &c., in the form of sheet, strip, wire, rod, tubes, and extruded sections, together with a number of finished goods produced from these materials. The non-ferrous metal house is panelled in copper and other alloys of this metal, has a copper roof, and in one of the rooms a nickel ceiling. There is a complete hot water system, showing the use of copper for pipes and boilers in a modern house. The stand will be lit by an intensive system of flood-lighting. A new plastic material, somewhat after the character of Bakelite, to which reference is made in another column, is also demonstrated on this stand.

On another stand of this company the Cassel cyanide case-hardening process will be demonstrated. Hardening by the cyanide process, of course, dispenses with all the time lost in packing the articles in the compound, luting the boxes, and in heating-through the non-conductive cement. Work can be hardened to a depth of $^1/_{64}$in. within one hour of entering the automatic furnace or to a depth of $^1/_{32}$in. in 2½ hours. Visitors to the Fair are invited by the company to bring their own small metal parts, such as pins, bolts, cups or washers, to be case-hardened while they wait. The plant required to operate the cyanide process is simple. The standard self-contained portable unit, which occupies a floor space of 27in. by 27in., with a height of 6ft. 6in. to the top of the canopy, will take 50 lb. of machine parts at a charge. This furnace has such recuperative capacity that it will bring its full load to the carburising temperature of 950 deg. Cent. within 20 min. to half an hour. A pyrometer supplied with the unit records the actual temperature of the molten mass of sodium cyanide.

Another exhibit demonstrates a development of the use of soda ash in the manufacture of iron, which is of great importance to British manufacturers of iron and steel. Briefly, the process consists of adding a quantity of soda ash to the ladle into which the molten metal is poured at different stages in its manufacture. It has been found that the addition of this cheap industrial chemical has the effect of purifying the iron, especially in reducing the sulphur content. Treatment with soda ash results, it is said, in a tougher iron, and at the same time lowers the cost of production. A working diagram will show clearly at what stages in the process manufacturers should apply the treatment, while a series of photographs will also illustrate the superior structure of the metal treated with soda ash.

On other stands of this company there will be

demonstrated the trichlorethelyne process of removing grease, which is non-inflammable, a method of cleaning rust off iron and steel, and a variety of paints and preservatives.

GREENWOOD AND BATLEY, LTD.

There will be several machines of diverse character on the stand of Greenwood and Batley, Ltd., of Leeds. They will include a section and mitre-cutting machine, a ¼in. cold rivet heading machine capable of producing 200 rivets a minute, a ¼in. automatic cold thread rolling machine, a 1-ton electric truck equipped with an Exide Ironclad battery of fourteen cells and 193 ampère-hours capacity, a 10 horse-power electric

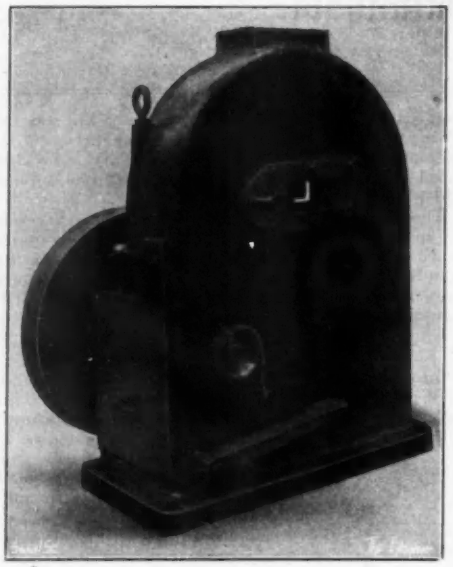


FIG. 2—ANGLE CUTTING MACHINE—GREENWOOD AND BATLEY

motor, and a number of models, steam turbine details, &c.

The section and mitre-cutting machine, of which we give two views in Figs. 2 and 3, is the invention of Mr. F. R. Hall, and is of the semi-rotary type. It will cut angles up to 2½in. by 2½in. by ⅜in., and is claimed to leave a square finish to the cut, so that it is unnecessary to grind the ends of bars to get a good finish. The machine will be shown cutting window frame sections.

In working, the moving blade, which is attached to a slide, is operated by a cam motion, and first grips the section against a fixed blade; during further movement of the cam the moving blade is partially rotated, shear-

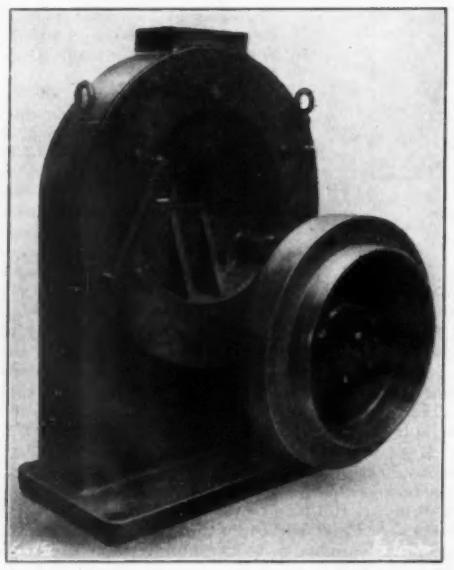


FIG. 3—ANGLE CUTTING MACHINE—GREENWOOD AND BATLEY

ing the section while it is supported by the stationary blade. The machine is arranged for direct drive from a line shaft. A foot lever-operated clutch is fitted, and allows the machine to run continuously or stop after each revolution with the blades open. A brake is provided for preventing the machine stopping with the blades partially closed. All the gears are of steel, and are machine cut from the solid. A gauge bar is provided to register repetition of lengths. When mitre cutting two sets of blades only are required to cut all four ways for each shape of section. The size of the blades is 4½in. wide by 1in. thick, and the gripping blades have a stroke of ⅜in. They make twenty-five strokes a minute, and require 5 horse-power. The driving pulley is 24in. in diameter by 2½in. wide, and should run at 200 revolutions per minute.

G. A. HARVEY AND CO. (LONDON), LTD.

On the stand of G. A. Harvey and Co. (London), Ltd., Greenwich Metal Works, London, S.E. 7, there will be the usual display of perforated metals, woven wire and ornamental guards for such things as radiators and fans. There will also be a considerable exhibit of steel-framed furniture for office and factory service.

Some idea of the wide range of perforated metals which are produced at these works may be gained from the fact that punches and dies are kept in stock for making slots 1½in. long by ⅜in. wide in ⅜in. steel plate, down to other punches for round holes only 0·015in. in diameter. The range of woven wire cloth is equally extensive.

Steel furniture is becoming fairly familiar to engineers, and appeals on account of its fireproof qualities and the fact that it is uninfluenced by climate and vermin; but Messrs. Harvey have carried the idea one step further and have produced a standardised form of steel office partition which has the merits of occupying a very small amount of floor space, while it can readily be dismantled and re-erected if it should be desired to rearrange the office accommodation.

F. J. EDWARDS, LTD.

There will be a wide range of machinery for the sheet metal and allied trades on the stand of F. J. Edwards, Ltd., of 406, Euston-road, London, N.W. 1. Among the items one of the most recently produced is the bending machine illustrated by Fig. 4. It is used for bending angles, tees and channels, and is, it will be seen, intended for bolting on a bench. The top roll is adjustable and pressure is applied by the screw shown. This roll, which is 4in. in diameter, is open

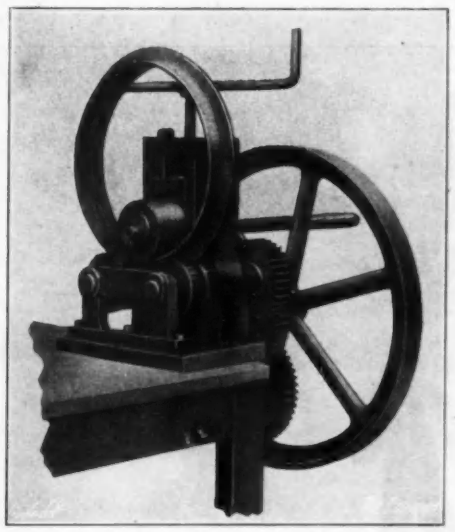


FIG. 4—BENDING ROLLS—EDWARDS

ended, so that a complete circle can be removed. The bottom rolls are 4½in. in diameter and are supported by outside bearings. A double-reduction gear is provided in the drive. Several sizes of this machine are made, capable of bending angles from 1½in. by 1½in. by ⅛in. up to 3in. by 3in. by ⅜in.

There will also be guillotines and shearing machines of several descriptions, machines for the cutting of irregular shapes in sheet metal, folding and bending machines in eight different varieties, a selection of power, hand and foot presses for metal stamping and forming work, swaging machines, bending rollers, jennies, wiring machines, grooving machines, paning machines and seam closing machines.

HOLMAN BROTHERS, LTD.

Holman Brothers, Ltd., of Camborne, Cornwall, will display a representative selection of their products, used in mining, quarrying, road-making, &c. The exhibits are to include air compressors, both stationary and portable, of the reciprocating and rotary piston types; air motors, one of which will have a portion of the outer casing removed, so that the mechanism may be examined; two types of portable hoisting or haulage devices driven by "H.S.B." air motors; and a scraper haulage of the latest type to which is coupled an air motor. This haulage and several other exhibits will be in operation, the air being supplied by one of the compressors. There will be, of course, a number of different patterns of rock drills and pneumatic tools.

One of the most novel machines on this stand will be, however, the drill sharpener, illustrated in Figs. 5 and 6, which is intended for services where it is not considered that the expenditure on a full-sized drill-sharpening equipment would be justified, but where something more expeditious and exact than the smith's hearth and anvil is desired.

As will be seen from the illustrations, the hammer portion of the machine is so arranged that it can be swung into either a horizontal or a vertical position, for upsetting or for swaging the end of the drill bit. The hammer is of the valveless type, with a 3½in. diameter piston and delivers its blows directly on the work. The bit being sharpened is held by air-operated clamps, but these add very little to the air consumption of the machine, as the maximum amount of movement is only ⅛in. The clamping is also direct and positive, without any links or toggles to wear and cause lost motion. The grips are operated by a foot pedal, while the hammer is controlled by a handle,

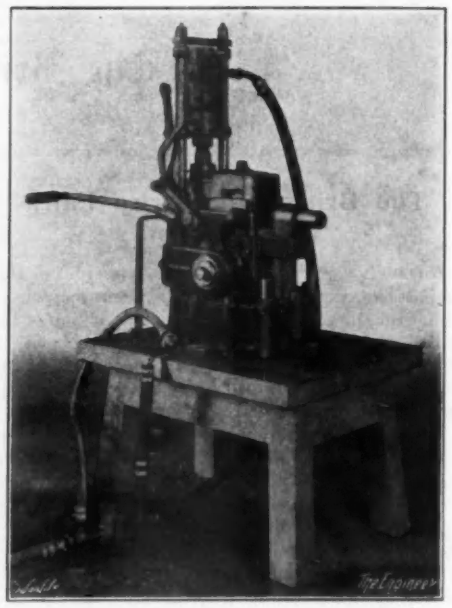


FIG. 5—DRILL SHARPENER—HOLMAN

leaving the smith's other hand free to manipulate the drill bit.

The operation is as follows:—The heated end of the steel is placed in the gripping dies, and, after the hammer has been swung into the horizontal position, clamped by the foot pedal. With the hand lever the hammer is brought into contact with the drill, and, by the same means, is set in operation and fed forward. When the upsetting is complete and pressure removed from the pedal, the raising of the hammer to its vertical position automatically releases the steel. The partly formed bit is then transferred to the lower forming die and the hammer set in motion to forge the wings by pressing down on the hand lever. Two

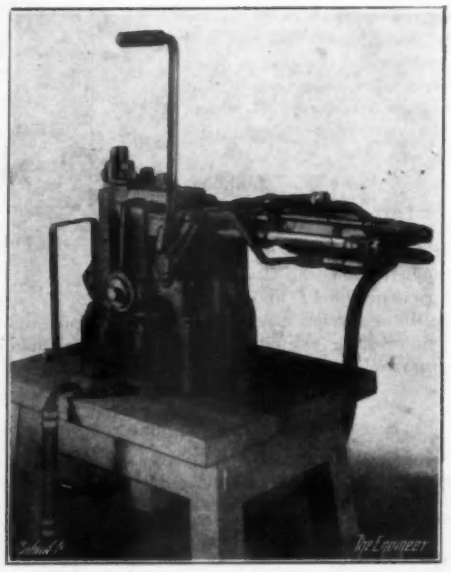


FIG. 6—DRILL SHARPENER—HOLMAN

or three repetitions of these two operations result in a perfectly formed bit.

The same firm will also be showing in the grounds of the Fair a machine for trepanning specimens out of concrete roads, for sampling purposes, which we have already described.

MARSHALL, SONS AND CO., LTD.

Marshall, Sons and Co., Ltd., of Gainsborough, will exhibit in the Quarry to Road Section, a "Cummer" portable 4–6 tons asphalt plant, of which we give illustrations; a bitumen kettle; a portable steam engine supplying power for the asphalt plant; a 6-ton oil-engine road roller; and a "Manumit" petrol motor roller.

The "Cummer" portable asphalt plant, for which

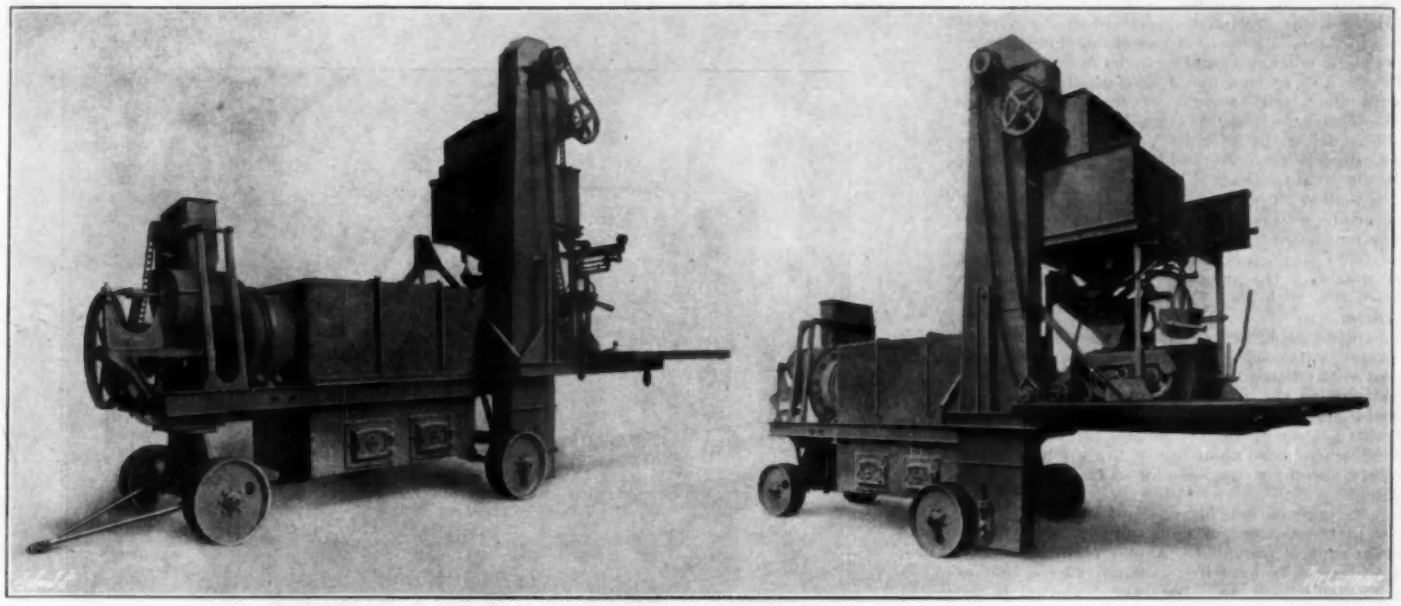
Marshalls have the sole licence for manufacture in Great Britain, is rated at 4 tons per hour, but this rating is far more nominal than actual, as with many such plants continuous outputs up to 7½ tons per hour have been obtained without exceeding the drying and mixing capacity of the plant. We gave a description of one of the earlier types of these machines in our issue of December 25th, 1925.

The main frame is made of steel girders, on which the rotating cylindrical drying chamber is erected above the oil-fired furnace. (The machine shown in our illustrations is coal fired, but the difference in appearance is insignificant). The cold materials elevator delivers into the drying cylinder, and the hot materials elevator to the rotary screen and divided bin, from which the material goes to a pug mill type paddle mixer where the hot bitumen and filler are added, and the finished surfacing material is produced.

The hot materials elevator is pivoted to swing down to a horizontal position for transport, and the portability provided by this arrangement is an outstanding feature of the new design. The working parts are clutch controlled, and a two-speed gear is fitted to the mixer drive to give a slow speed when large material is dealt with. A portable oil-fired kettle of 500 gallons capacity supplies the heated bitumen to the plant. The driving power is supplied by a Marshall 6 N.H.P. portable steam engine fitted with an oil-fired furnace and capable of developing 21 B.H.P., although the "Cummer" plant needs only 15 B.H.P. to drive it under full load. The boiler working pressure is 120 lb. per square inch.

The 6 tons road roller has a two-cylinder high-speed four-stroke engine of the "cold-starting" type, which runs on cheap heavy fuel oils at a consumption of 0·42 lb. per B.H.P. per hour. No auxiliary starting engine, no electric gear, no magneto, no carburetter, petrol prime-up, nor cartridge are needed or are provided for. It has a quick reverse action for rolling on asphaltics, with three speeds in either direction of travel.

A smaller and totally different design of roller is exemplified by the Marshall "Manumit" motor roller, of which we have given a detailed description in connection with a previous Fair. The model to be shown weighs 16 cwt., and a 12-cwt. model is also made. The power unit is a four-stroke "J.A.P." petrol engine. The transmission is effected through a flexible coupling and worm reduction gear, in which ball bearings are employed, to an idler roller which bears on a track inside the circumference of the roller itself.



FIGS. 7 AND 8—CUMMER ASPHALT MIXING MACHINE—MARSHALL

W. CANNING AND CO., LTD.

AN interesting and novel machine is to be shown on the stand of W. Canning and Co., Ltd., 133, Great Hampton-street, Birmingham. It is for the chromium plating of small articles, such as screws and rivets, and is illustrated in Fig. 9.

The goods to be plated are placed in a cradle immediately following the usual barrel nickel plating, because goods to be chromium plated must, of course, first receive a deposit of nickel. No wiring up of the articles is necessary, and the output is practically continuous. The cradle is supported on counter-balanced arms, and after loading is lowered into the plating vat and given a slow rocking motion by means of a small motor driven lever. After plating, the cradle is swung clear out of the plating vat into the chrome swill. The fumes evolved during plating are extracted by an exhaust system, consisting of a fume duct, solution recovery tank, and exhaust fan, all incorporated in one unit. The apparatus can be arranged for gas, steam, or electric heating by means of a water jacket, the temperature being automatically controlled by a thermostat.

A model vat is also to be shown in which the solution tank is arranged for steam heating, and complete sets of cathode and anode rods and anodes will be with it. The system of fume exhaustion and condensation is claimed to be such that it fully protects the health of the operator, and yet does not impede rapid and economical output. Chrome-plating, the makers say, has now passed the experimental stage, and is no more difficult to carry out than any other form of electro-deposition.

There is to be a working model of a fully automatic nickel-plating plant, 10ft. in length, with cleaning, swilling, and acid dipping tanks, preceding the plating vat, followed by cold and hot swills. Fully automatic plating plants of this class are now used in the deposition of nickel, copper, brass, silver, cadmium, and zinc, and, in fact, may be applied for the deposition of any metal when the quantity of work warrants the outlay. They are also made to deposit two metals in their proper sequence, such as copper and nickel or nickel and silver or copper, and subsequent oxidising. The various vats are placed in line, one behind the other, in their proper order. Conveyor chains are arranged to move slowly over the line of vats, and the articles are loaded on insulated suspenders, the latter being arranged in two or three rows on cross rods attached to the conveyor chains. The suspended articles pass successively through all the preparatory cleaning and swilling vats before going into the depositing vat, and, finally, through swilling and drying-out apparatus after deposition.

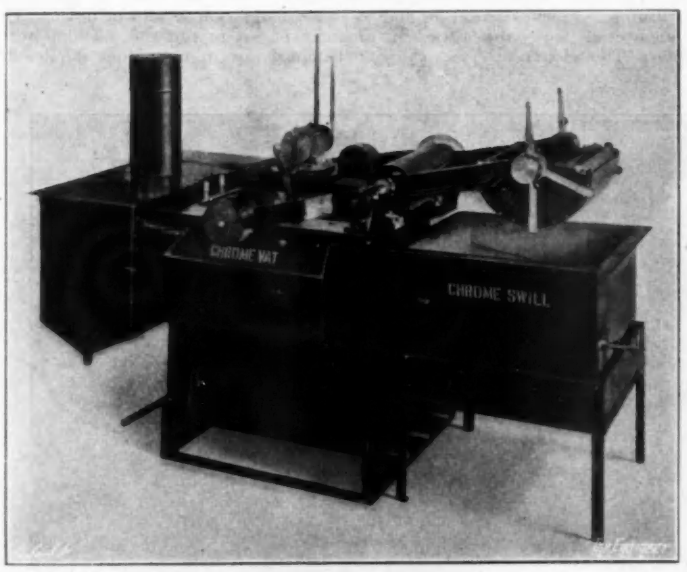


FIG. 9—CHROMIUM PLATING VAT—CANNING

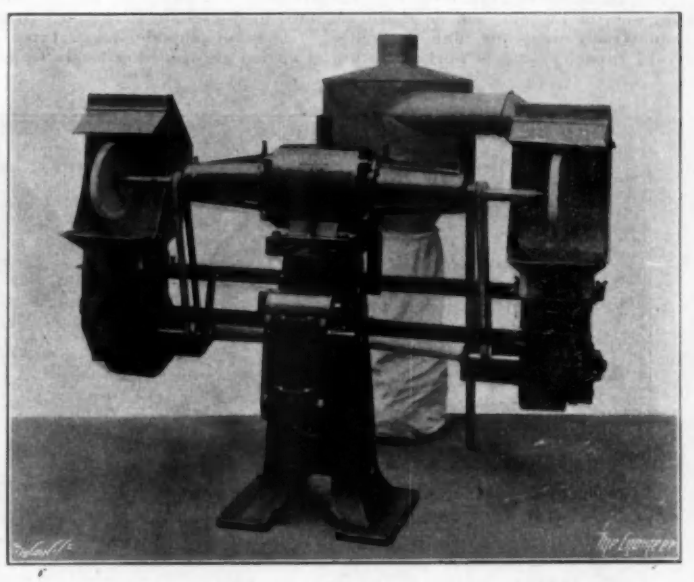


FIG. 10—POLISHING AND BUFFING MACHINE—CANNING

The polishing and buffing machine shown in Fig. 10 is equipped with a self-contained dust-extracting unit, which can also be attached to polishing lathes and polishing motors. The sheet iron mop hoods are fitted with adjustable trays and cowls, and trunking connects with a cyclone dust collector at the back of the machine. Independent fans are provided for each hood. The A.C. polishing motor has extra bearings for the spindle, the snouts having a bearing

at the end in order to strengthen the spindle to withstand the polishing load. The motor is therefore equipped with four bearings, two on the inner shields of the motor and two on the outer ends of the snouts.

Among the other machines to be exhibited on this stand there is an automatic polishing apparatus for cylindrical goods of plain and special shapes. The whole apparatus tilts, so that the chuck spindle can be run at a different angle to the polishing spindle for applying a cross-grain polish; a universal attachment gives further adjustment of the angle of the chuck spindle to the polishing spindle, and a separate adjustment for height is provided. The apparatus is automatic, several controls being provided for starting and stopping, to suit articles of different shapes and sizes. A battery of three or even four of these machines can be run by one operator.

There is also to be a motor-driven polishing lathe, with the motor self-contained in the machine, giving all the clearance possible round the mops. The spindle is driven by a Multi V belt drive from the motor, which is mounted on a hinged base plate fitted inside the main casing. The belt tension adjustment is made by operating a hand wheel at the back of the machine to raise or lower the base plate. The starter is carried inside the main casing, and is operated by a push-button control from the front of the machine. The arrangement of the bearings in the casing is such that the spindle may be easily withdrawn.

An electric cable heater for plating solutions and hot water vats consists of an electric cable coil covered with chemically pure lead, which is laid in the bottom of the vat, and connected by plug or otherwise according to specific requirements. Single or double heats with double control can be arranged for, and when more than one vat is to be heated, automatic earthing devices for A.C. or D.C. are available.

For the prevention of accumulation of foreign matter in the bottom of a plating vat, a portable filtration unit is provided. A fast plating solution must, of course, be kept free from particles of matter in suspension, which are liable to be deposited on the articles at the same time as the metal, causing a rough surface and trouble in finishing. The only method of eliminating this is by absolute cleanliness of the solution by efficient filtration. This portable form of filter is designed for use where no filter unit is fitted integral with the vat. It is motor driven and consists of a pump and filter chamber with suction and delivery hose, mounted on a light truck, making a self-contained mobile outfit ready for immediate use and easily placed in position alongside any vat. The filtering head is of acid-resisting metal and is clamped to a container which is bolted to the truck. The actual filtering media are attached to the head. An acid-resisting phosphor bronze pump, which has a capacity of 300 gallons per hour, is mounted on a cast iron bedplate bolted to the truck, and is direct coupled to a motor.

Ruston-Bucyrus, Ltd.

An excavator exhibited by the Ruston-Bucyrus Company, of Lincoln, will be shown at work in the grounds adjoining the Fair buildings. It is of ¾-yard capacity, and is worked by an oil engine of the solid injection type. At the Fair it will be working as a drag-line, but it will be noticed that in the illustrations which we give in Figs. 11, 12 and 13 it is represented as being of the dipper or shovel type. The machine is, however, readily adaptable to act as a shovel, a drag-line, a drag shovel, a grab or a pile driver, the only difference being that the jib and its gear are altered. It has also been so devised that the same mechanism can be driven by either an oil engine, a petrol engine, or an electric motor with a minimum of delay in the conversion. In either case only one power unit is required for all the operations, but with electric drive a separate motor can be arranged on the jib for racking out the dipper, if that method is preferred to rope operation.

The machine shown at the Fair will be driven by a four-cylinder airless injection heavy-oil engine of 62 H.P. with cylinders 5¾in. by 8in., running at 800 r.p.m. A small petrol engine driving a single-cylinder compressor is provided for starting up the main engine, but is, of course, used only occasionally, as the main engine is kept running during working hours, and all the manœuvring effected by means of clutches. It is noteworthy that if a petrol engine is employed the makers advocate one of 76 H.P. and for an electric motor 40 H.P.—a good testimonial to the overload capacity of electric motors and the "staying" power of heavy-oil engines.

The understructure and caterpillar travelling gear of the Ruston-Bucyrus machines have been so recently described in The Engineer that it is not necessary to deal with them here; but we may perhaps emphasise the fact that the frame is a single steel casting, which ensures that all the running parts are kept in proper alignment. Power is transmitted from the engine to the winch through a double flexible coupling and then through a train of machine-cut gear wheels with modified Maag teeth running in an oil bath. The shafts all run in ball bearings. The main driving shaft is clutched to the winch drums by means of outside band-type clutches connected with the operating levers by toggle motion. This gear minimises the effort necessary on the part of the driver and enables him to leave the lever in the "on" position. The clutches for operating the swinging and travelling motions are also of the outside band type. Brakes are provided to hold the machine up to its work when digging and to prevent the revolving frame from turning when the excavator is travelling.

This machine is capable of digging to a depth of 15ft. or 16ft. at a radius of about 40ft. and will dump at a height of 15ft. above ground level. As a shovel it will cut to a height of 21ft. 6in. and will dig to a depth of 6ft. 3in. below the floor. The dumping height is then 14ft. 9in. As a crane it will lift about 2½ tons at a radius of 30ft. and it will travel at a speed of 0·85 mile per hour. It is noteworthy that all the heavy machinery is arranged behind the king-post, so that no counterbalance weight is necessary and the engine is consequently relieved of unnecessary effort.

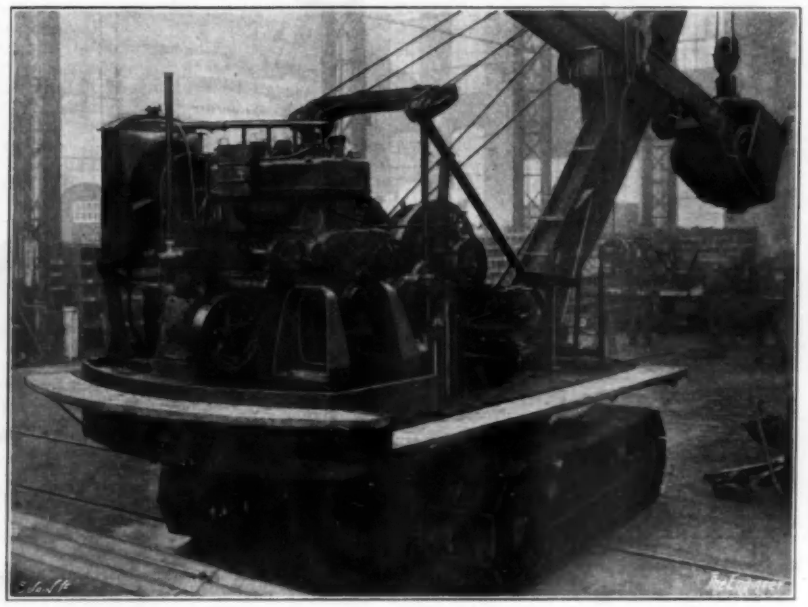
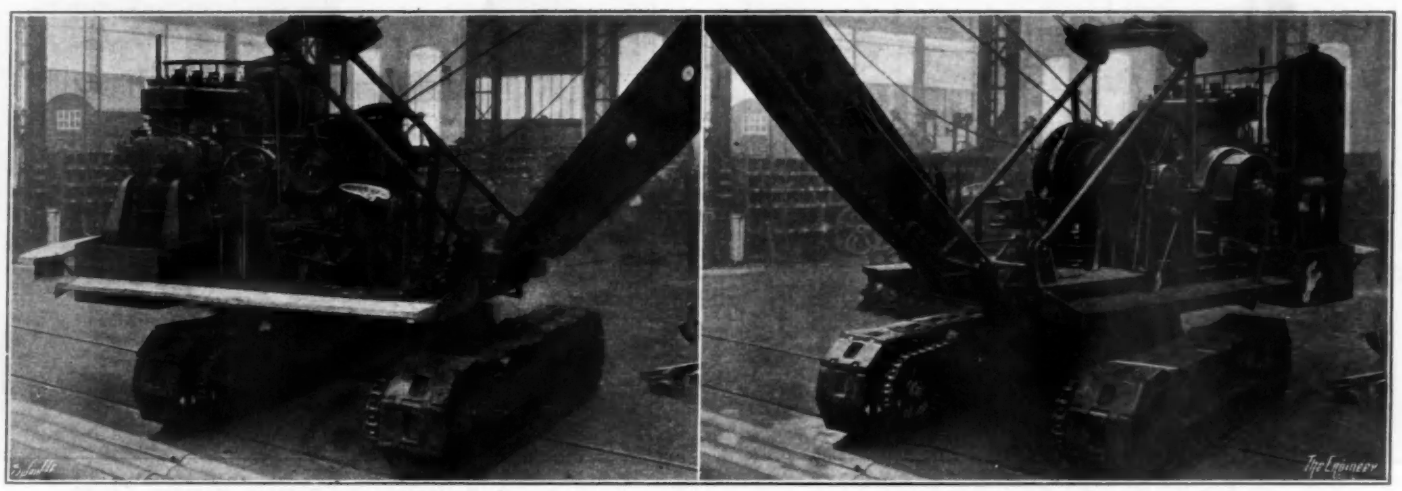


Fig. 11—Oil Engine Driven Excavator—Ruston-Bucyrus



Figs. 12 and 13—Oil Engine Driven Excavator on Caterpillar Tracks—Ruston-Bucyrus

John Hands and Sons, Ltd.

This year the products of both John Hands and Sons and of Hollings and Guest, of Birmingham, are to be exhibited on one stand, as these two firms have recently amalgamated their interests.

The machines are, in general, of a familiar nature, but the press illustrated in Fig. 14 is of unusual size, being capable of delivering a blow of 125 tons, and has a frame of the "chain link" form. That is to say, those parts of the frame which have to take up the reaction of the blow are a loop-shaped casting, reinforced on either side by long tie bolts of forged steel. These bolts are put in place hot, so that they have an initial tension and take their proper share of the load. The whole frame is, in fact, a very rigid structure, with the object of getting the greatest possible intensity of blow at the dies. The screw which operates the top die is, it will be seen, driven by a friction wheel, which is engaged by either one or the other of two discs, according to the stroke required—up or down. The reversing gear can be set to run the machine automatically continuously or in individual strokes by hand. There is an ejector beneath the table which can be worked automatically or by a foot treadle. On this stand there will also be a number of other presses of both mechanical and hydraulic types and some scrap bundling presses.

A further exhibit to be displayed by Hollings and Guest is a set of vertical belt-driven three-throw pumps designed for the pumping of sewage and other liquids. The drive is by means of fast and loose pulleys and single-reduction gearing to the crank shaft, which is of the treble-block type. The connecting-rods are connected to the rams by means of a spherical ball end mounted on a phosphor-bronze pad and fitted

with gun-metal retaining covers. This method of connection gives long life and allows for adjustment. The rams are all fitted with gun-metal liners and run in deep cylindrical guides, whilst the pump barrels are fitted with quick-opening covers and clack valves specially designed for pumping sewage. There is an air vessel on the delivery side, while pressure and vacuum gauges are provided. The glands and neck rings are bushed with gun-metal. The particular pumps to be exhibited are capable of delivering 150 gallons of sewage sludge per minute against a head of

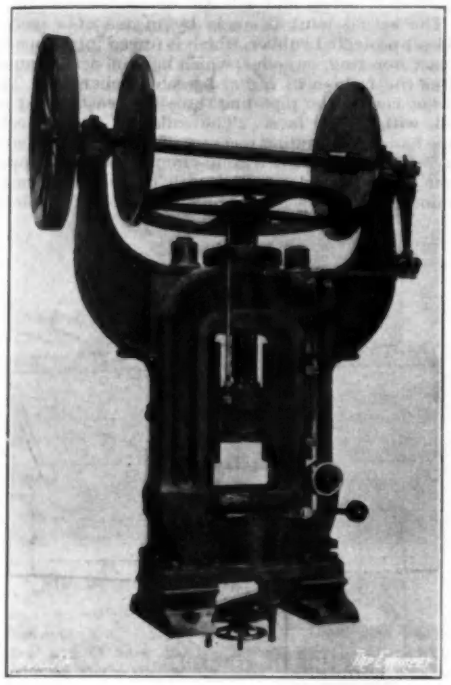


FIG. 14—125 TON PRESS—HANDS

230ft. They have rams 8½in. diameter by 9in. stroke, running at 30 r.p.m.

A. REYROLLE AND CO., LTD.

Apparatus representing various branches of their productions will be exhibited by A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne. Horizontal draw-out switchgear for power station and sub-station indoor service will be exemplified by a four-panel board, composed of a set of switchgear, rated at 7000 volts, 400 ampères, and a single panel of duplicate bus-bar switchgear—see Fig. 15—rated at 11,000 volts and 1600 ampères. On the former switchboard one of the circuit breakers is to have a glass panel in the tank in order to show the arrangement of the contacts. Trucks for lowering the circuit breaker and the tanks form part of the equipment.

An enlarged reproduction of an oscillogram will show the performance of a circuit breaker during a test at the Hebburn Works. Outdoor sub-station switchgear is to be represented by some non-draw-out switchgear mounted on framework, and a tee-off isolating unit for insertion in a ring main with a switch fuse tee-off for a consumer. Both units have been designed with a view to promoting economy in outdoor sub-station lay-out. There is to be a selection of flame-proof apparatus for mines, including an oil-break gate end switch combined with a small lighting transformer, the transformer winding being assembled in the same tank as the switch mechanism, and is protected by series over-current trips and fuses, all incorporated in the combined unit, which is designed to comply with both British and Continental regulations for flame-proof enclosures. Another flame-proof switching unit will consist of a reversing switch with fuses in the same enclosure and developed mainly for use in connection with shot holes and rock drills. For the incoming cable a detachable gland is provided and a plug interlocked with the switch handle for the outgoing cable to the drill. The exhibit

FIG. 16—FLAME-PROOF PLUG AND SOCKET—REYROLLE

includes 200 and 60-ampère detachable cable-sealing boxes or "flit plugs."

Flame-proof plugs and sockets—see Fig. 16—for currents up to 100 ampères at 660 volts will be on view, and one of these fittings will be shown in service on a Siemens-Schuckert drilling machine. One of the most interesting exhibits apart from switchgear will be a Reyrolle electrode water heater and steam raiser—Fig. 17—suitable for pressures up to 11,000 volts and for loadings up to 2000 kW. Load control is obtained by raising or lowering movable electrode shields, which gives the effect of lengthening or shortening the current path between the electrodes. The equipment includes the usual inlet and outlet valves, a safety valve, a water level gauge, and a motor-driven pump for circulating the water over the electrodes.

A domestic thermal storage water-heating cylinder is also to be shown, and another device for hot-water service will be a self-contained wash basin and storage water heater developed in conjunction with Adamsez, of Scotswood, Newcastle-on-Tyne. The water heater is contained in the stoneware pedestal of the wash basin, which, as far as size and appearance are concerned, does not differ materially from an ordinary wash basin. Only a cold water supply and a source of electricity are needed, long expansion pipes, obviously, being unnecessary. Examples of immersion heaters for water and oil heating will be shown in the forms of single units and banks of units, with bus-bars and cable-dividing boxes.

Relays suitable for the most modern protective

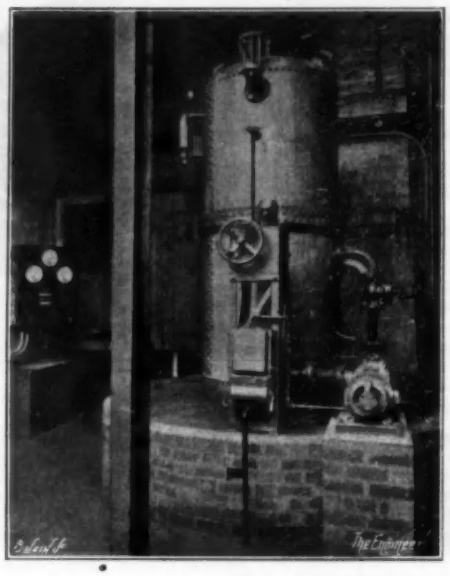


FIG. 17—ELECTRODE BOILER—REYROLLE

schemes are to be shown, also complete control boards for controlling 66,000 volt switchgear, air-break switchgear for factory and general use, and cooker switches and plugs and sockets for general domestic use. The air-break switchgear is suitable for frequent operation on 660-volt circuits and is capable of carrying 25 per cent. over-load continuously without overheating. The movement is of the quick double make-and-break type, on each pole, the contacts are self-aligning, and the gear conforms in all respects with B.S.S. No. 124. Other exhibits will consist of heavy-duty cartridge fuses, an outdoor pole mounting distribution box, cable-sealing bells and cable-sealing and dividing boxes. Many of the firm's pole-mounting distribution boxes have been supplied for controlling flood-lighting circuits from outdoor sub-stations. The equipment consists of a sheet steel box containing six fuses and three protected switch plugs for controlling three 250-volt, 15-ampère circuits. All the switchgear for the electrical restaurant at the Fair was supplied by A. Reyrolle and Co., Ltd.

LANCASHIRE DYNAMO AND CRYPTO, LTD.

Visitors to the Fair who are interested in fractional horse-power interchangeable A.C. and D.C. motors, will find fifteen examples of these machines on the stand of Lancashire Dynamo and Crypto, Ltd., of Trafford Park and Acton-lane, Willesden, N.W. 10. There will be examples of the company's larger A.C. and D.C. industrial motors, together with a motor generator set. A motor of particular interest to those engaged in the motor car industry is the flame-proof petrol pump motor shown in Fig. 18. The machine is said to have passed the stringent Sheffield tests. The particular machine shown will be a repulsion motor, but the firm also manufactures a similar D.C. type. A special flanged mounting repulsion motor which can be used for many classes of direct driving, is also to be shown, whilst the gas industry will be

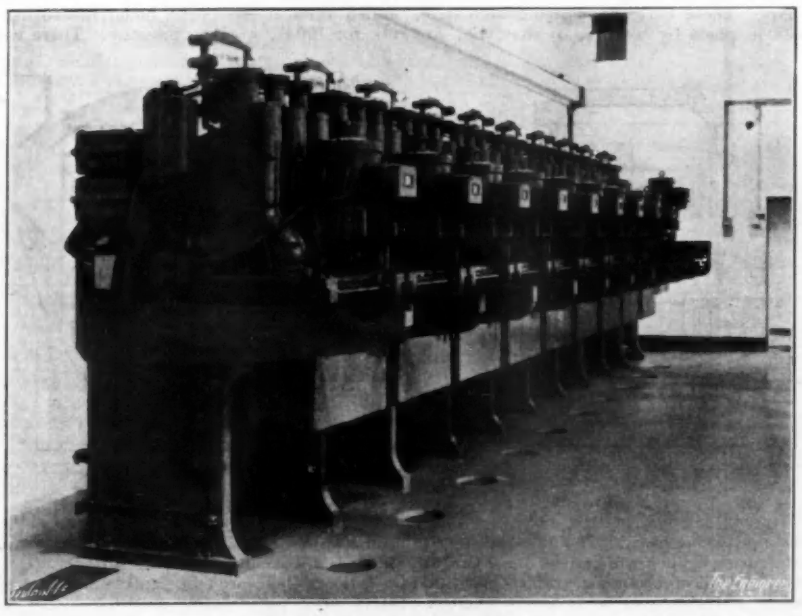


FIG. 15—DUPLICATE [BUS-BAR] SWITCHGEAR—REYROLLE

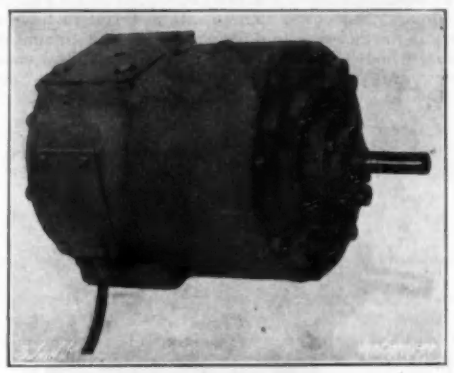


FIG. 18—FLAME-PROOF MOTOR—LANCASHIRE

catered for by the "Lancashire" gasworks motor, as described in our issue of August 7th, 1931.

A system of ventilating motors that has come to the fore within recent years is the closed air-ventilating system, which is now extensively employed for large electric motors and generators, and the parts of a "Tefco" squirrel-cage motor, in which the air circulates between the stator and an outside case, are shown in Fig. 19. A machine of this type will be shown, its output being 13½ H.P. at a speed of 715 r.p.m. Other exhibits will consist of an A.C. constant potential battery-charging equipment, capable of charging 600 assorted L.T. and H.T. batteries a week,

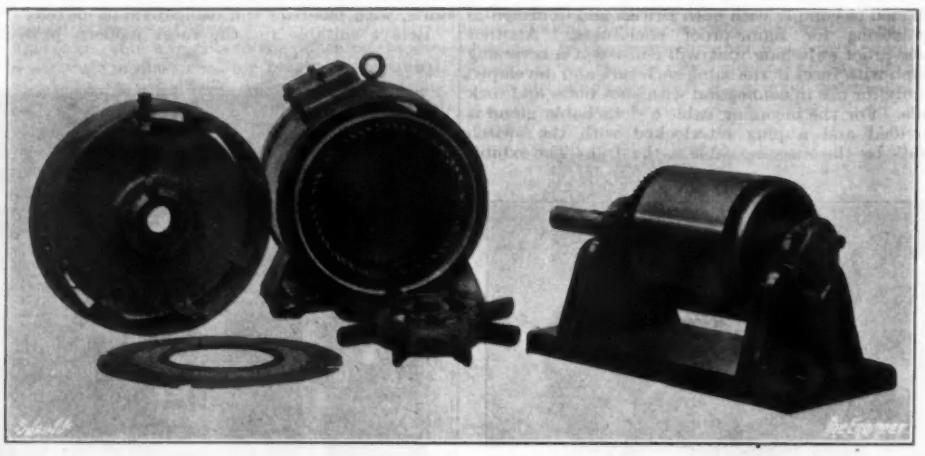


FIG. 19—PARTS OF ENCLOSED VENTILATED MOTOR—LANCASHIRE

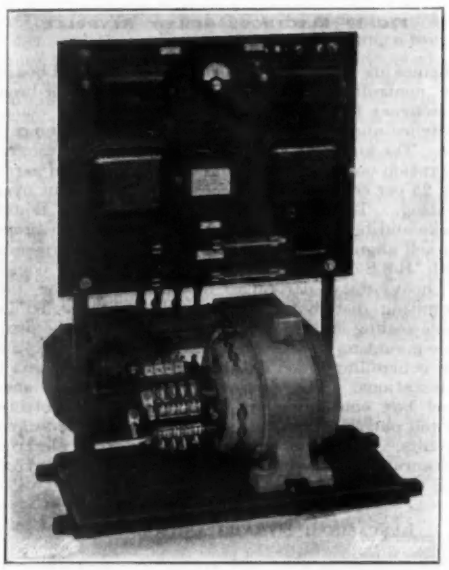


FIG. 20—CINEMA ARC RECTIFIER—CRYPTO

and a self-contained cinema arc equipment—Fig. 20—for arc projectors. These sets are said to have a very high efficiency, and owing to the small amount of space which they occupy and their low initial cost, they are particularly useful when supplies are

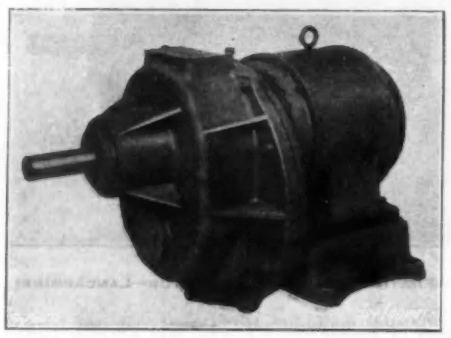


FIG. 21—GEARED MOTOR—CRYPTO

changed from D.C. to A.C., or when old equipment has to be brought up to date.

Crypto-Langham geared motors, as illustrated in Fig. 21, have been introduced to meet the many demands for a motor combined with a reduction gear. They are said to be particularly useful in the meat and catering trades, and are used, among other things, for driving mincers. Several new electrical devices appealing to the general public will be shown for the first time, including an electric hand and face dryer, an electric boot cleaner, and an electric coffee mill. Some Lancashire-Crypto electric refrigerators with a capacity of 4 cubic feet, will be shown in operation. These refrigerators have two main compartments, the lower of which accommodates the complete mechanical unit, which can be removed from the cabinet in a few minutes. To reduce the frequency with which the motor has to be started and stopped the evaporator coil is immersed in brine. The base of the compressor constitutes the liquid receiver and the cooling fan operates inside the condenser coils.

F. PARKER, LTD.

The most novel exhibit on the stand of Frederick Parker, Ltd., Catherine-street, Leicester, will be the stone breaker, which we illustrate by the drawing, Fig. 22.

In this machine the stone is broken by throwing it violently off a rotor against a series of angular beater bars that form the roof of the casing. The impact of the stones on these bars splits the stones up and a remarkably consistent cubical form is given to the crushed stone, while the production of dust is reduced to a minimum. The size of the product is dependent upon the speed of the rotor, which may range from 250 to 450 r.p.m. When working at a speed of about 350 revolutions, gravel is broken to about ¾in. size, with a small percentage of rejects. In this connection it is noteworthy that it is unnecessary to provide grid bars at the outlet of the machine for the trapping of oversize stone, as the breaking is effected in a single operation and is dependent only on the speed of the rotor.

The rotor, it will be seen from the drawing, is built up of two cast steel discs, which are keyed on to squares on the main driving shaft, that carry the hammers or beater bars. These bars are of manganese steel, and are held in place by wedges, so that they are easily replacable when worn. The breaker bars in the top of the casing against which the stone is thrown, are of cast iron, chilled to a considerable depth, and are so shaped that they can be reversed when one side is worn. The sides of the upper part of the casing are of heavy steel plate, while the lower part is a solid casting of semi-steel. The rotor shaft is 7in. in diameter at the centre and runs in long, dustproof, ring-oiling bearings, 5in. in diameter. The shaft is keywayed at both ends, so that the driving pulley may be placed on either hand. These machines are made in two sizes, one which has a capacity of from 15 to 25 tons an hour, and requires 25 horse-power, and a smaller size for about 8 to 10 tons an hour needing 14 to 16 horse-power.

On this stand there will also be exhibited a number of other machines for road-making, quarry, and building work, most of which are familiar to our readers.

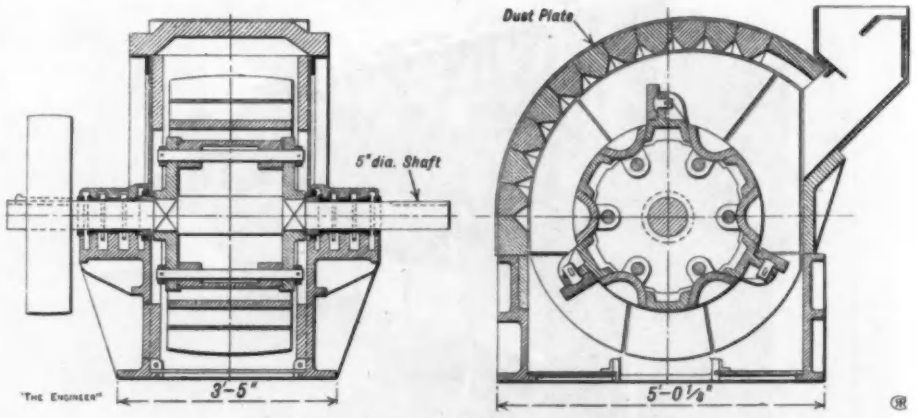


FIG. 22—IMPACT STONE BREAKER—F. PARKER

THE STANTON IRONWORKS COMPANY, LTD.

The most novel feature on the stand of the Stanton Ironworks Company, whose works are near Nottingham, will be the pipe joint illustrated by Fig. 23, which is to be shown in connection with a display of Stanton-De Lavaud spun cast iron pipe. The merit of the joint lies in the fact that it has a considerable degree of flexibility and, consequently, allows the pipe to adapt itself to subsidences in the ground in which it is laid and will still remain water-tight.

The actual joint is made by means of a gasket of lead-protected rubber, which is forced into place by a cast iron ring, or collar, which has an action much after the fashion of a gun breech mechanism. The socket end of the pipe has three lugs cast round its rim, with helical faces. The collar on the adjacent pipe has corresponding recesses. When the two parts have been assembled a semi-circular rack is slipped over the pipe and engaged with the lugs. A small pinion on a stub shaft is threaded through a hole in a lug on the collar and a tommy bar used on the pinion shaft to rotate the collar and tighten up the joint on the helical faces of the lugs. It is said that these joints can be made at the rate of one per minute.

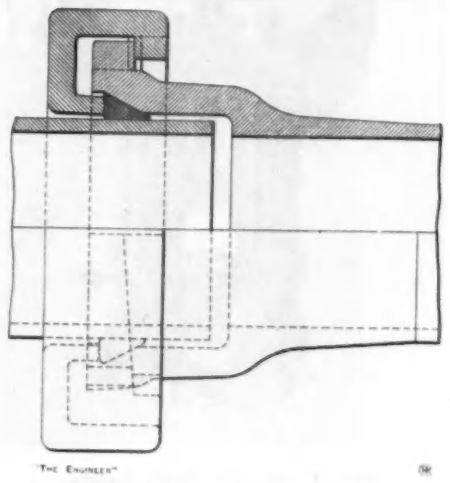


FIG. 23—PIPE JOINT—STANTON

On this stand there will also be a display of cast iron paving blocks, which are claimed to be cheaper than granite setts.

JOHN THOMPSON, LTD.

John Thompson (Wolverhampton), Ltd., of Wolverhampton, will have two stands in the Fair grounds and another in the buildings. Outside there will be a dish-ended Lancashire boiler with corrugated flues and a superheater, suitable for a pressure of 210 lb. per square inch; a self-contained "Economic" boiler; and a vertical cross-tube boiler measuring 13ft. by 6ft. for 100 lb. working pressure. There will also be some water softening plant, including a pressure sand filter and a Kennicott zeolite softener.

Indoors there are to be specimens of steel flooring, steel sash bar window frames, and a variety of vessels, all of which have been welded by either the water gas, oxy-acetylene, electrical or fire process, made in stainless steel, mild steel, aluminium and copper. There are to be some vessels lined with lead and with acid-resisting enamel, and a water softener for household use. An illuminated working model will show the construction of the makers' water-tube boiler.

ROBERT HUDSON, LTD.

Almost an innovation has been organised at the Fair this year in the arrangement of a variety of civil engineering appliances in the open, under

working conditions, and among them there will be those of Robert Hudson, Ltd., 38A, Bond-street, Leeds, an item of which we illustrate in Fig. 24. This tipping truck, or, rather, a train of them, is to be shown in conjunction with a Ruston-Bucyrus excavator and a Hunslet oil locomotive; but at the moment we are only concerned with the tipping truck.

It might, perhaps, be better to describe these vehicles as wagons, rather than trucks, as they have a capacity of 300 cubic feet, are made for the standard 4ft. 8½in. gauge, and will carry at least 15 tons of useful load. They are made of several different strengths; thus, for instance, it is not necessary that the body should be of such heavy gauge material if it is to be used for the conveyance of earth, sand or gravel, as it must be for limestone, granite or slag. The body is made of mild-steel side and end plates, with a solid pressed steel bottom, strengthened by

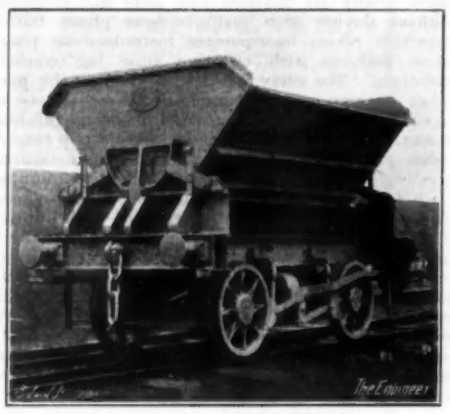


FIG. 24—SIDE-TIPPING TRUCK—HUDSON

rolled sections. The trunnions on which the load is tipped are of cast steel. As will be seen from the engraving there are two catches, which bear against these trunnions and hold the body upright in normal running, but when either pair of these catches is released the wagon automatically dumps its load and returns to the filling position. The frames are of rolled steel channels and are equipped with draw and tripping gear so that the wagons can be coupled-in in an ordinary goods train. The wheels are 36in. in diameter and have steel tires. The axle-boxes may be either of cast iron, with brass bushes and oiling pads, or may have Skefko ball bearings, in which case it is only necessary to lubricate, by means of a grease gun, about every three months. The springs are of the laminated type and hand braking is arranged on all four wheels.

B.E.N. PATENTS, LTD.

A variety of small machines, such as paint-spraying plant, compressors and fans, will make up the exhibit of B.E.N. Patents, Ltd., of 92, Tottenham Court-road, London, W. 1. In the engraving Fig. 26 we illustrate a "Flex-Shaft" machine for mechanical rubbing and polishing. Similar machines will be shown in a number of different arrangements. The flexible shaft is coupled with the driving motor, which runs at 1500 r.p.m. and variety of heads and discs can be attached to the shaft so that the machine is capable of performing all kinds of polishing operations. For rubbing, a special geared-down right-angle head is available, giving a speed of about 780 r.p.m. A quick make and break switch is suspended from the motor in a position such that it can easily be reached by the operator. The driving motor may be of ¼ or ½ H.P. The apparatus, including 5ft. 6in. of flexible shaft, weighs 70 lb. Besides the model just described, which is particularly suitable for line production where each machine will always be doing the same job, there will be a number of pedestal models fitted with four speeds. One of these to be shown has speeds of 825, 1460, 1700, and 2500 r.p.m. respectively, and is thus adaptable to a number of different uses and operations, such as grinding, metal sanding, glass edging, and cellulose polishing. The motor is totally enclosed and the speeds are obtained from stepped pulleys and a

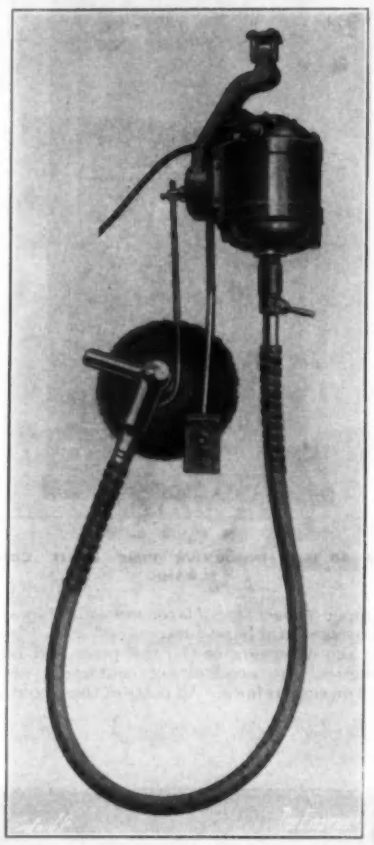


FIG. 26—FLEXSHAFT MACHINE—B.E.N.

belt drive between the motor and the countershaft. In other respects the machine is similar to that already described. Other exhibits on the stand will be portable oil engine and electric motor-driven compressors, paint-spraying plant and exhaust fans.

GOODWIN, BARSBY AND CO., LTD.

Of the several interesting exhibits on the stand taken by Goodwin, Barsby and Co., Ltd., of Leicester, the gravel washer illustrated in Fig. 25 is certain to attract attention, while the breakers and granulators shown are good examples of this class of machine.

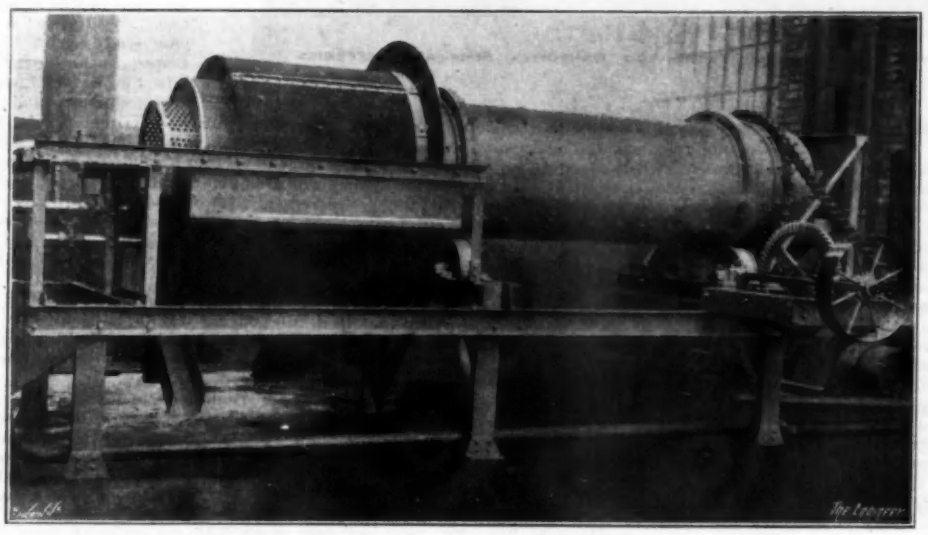


FIG. 25—GRAVEL WASHING MACHINE—GOODWIN, BARSBY

A gravel-washing machine is, as we know it now, essentially a steel plate cylinder, provided with fittings to agitate and progress the material under treatment through a stream of water. The cylinder of this exhibit has two turned cast iron rings on which it rotates, supported by four rollers. A feature is the provision of solid rubber tires on these supporting rollers, with the object of reducing wear on the roller tracks and eliminating the effects of vibration. Various forms of driving gear are possible, and the method adopted in the present instance, and shown in the illustration, is chain gearing.

Washing cylinders are constructed on one of two general principles, and there is much discussion as to which is most effective, but each system has its advantages, according to circumstances. In the first case, the gravel progresses along the cylinder assisted by a strong stream of water flowing in the same direction. This method is known as the Uni-Flow principle, and the washing cylinder only serves to loosen the gravel and sand, while the water holds the silt and foreign matter in suspension. The solid materials are separated on leaving the cylinder. A stream of washing water carrying with it sand and silt, is usually discharged into some form of dewatering device to reclaim the valuable clean sand, and the gravel is graded on screen extensions, as shown in the illustration, Fig. 25. A final rinse is given to the product by sprays of water directed on to the screens, and this operation serves also to increase the efficiency of the screening process.

In the second type of washer, known as the contra-flow, the gravel and water flow in opposed directions, and separation of the dirty from the valuable material is, therefore, accomplished in the cylinder itself. The washer exhibited is of this type. As in the first case, grading and final rinsing is performed in a nest of screens attached to the end of the cylinder. In the Goodwin Contra-Flow washer, three compartments are provided, and since the dirty water is not allowed to mix with the clean, and the gravel is transferred from compartment to compartment by means of a set of perforated scoops fitted to the end plate of the compartment, the gravel is scoured three distinct times in successively cleaner water. The factors determining the principle which should be used in any given circumstances are the amount of the water supply available, and the percentage of dirt to be removed from the raw gravel.

The Uni-Flow machine for a given size of cylinder has, it is claimed, a greater output, and requires more water. The Contra-Flow has a lower output than a Uni-Flow of the same size, but can be used with a less quantity of water. It is also more adapted for the efficient cleansing of dirty materials.

THE COVENTRY CHAIN COMPANY, LTD.

The Coventry Chain Company, of Spon End Works, Coventry, is, it will be remembered, now associated with Hans Renold, Ltd., of Manchester, and Brampton Brothers, of Birmingham, and the three firms will be exhibiting in conjunction.

The exhibits will include specimens of standard chain drives embodying simple, duplex, and triplex roller chains, and a range of sample chains for such purposes as conveying, cutting, and balancing; bush chains, long-pitch roller chains, inserted block chains, oil-well chains, escalator chains, and sugar cane chains. There will be some chain cases arranged for oil bath lubrication, Renold chain clutches and

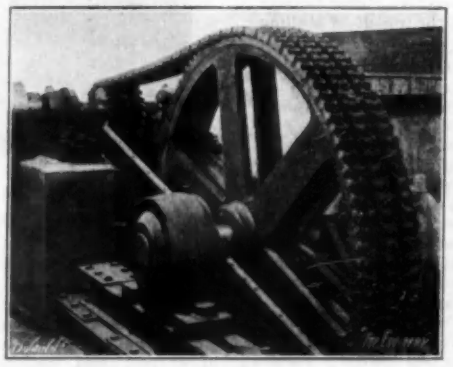


FIG. 27—CHAIN DRIVE—COVENTRY

couplings, and a push-and-pull remote control gear, operating machinery on the stand.

Several of the drives will be seen in motion, and a typical example is that shown in Fig. 27, which is for a cork mill in an Austrian linoleum factory. It is to transmit 175 horse-power, and the wheels have 21 and 109 teeth respectively. The centres are 4ft. 3in. apart, and the chain is of the 1½in. pitch triplex roller type. The speeds of the two shafts are 750 revolutions per minute (driving), and 140 revolutions per minute (driven). These chain drives have been found by the National Physical Laboratory to have an efficiency of 98 per cent. over a long life.

IGRANIC ELECTRIC COMPANY, LTD.

One of the most original exhibits of the Igranic Electric Company, Ltd., of Bedford, will be an inductive time limit control panel, which has been introduced for the purpose of eliminating certain difficulties associated with the usual types of D.C. controllers. The new apparatus, which is devoid of complications, ensures uniform acceleration of the

motor under the time limit principle at a rate which is independent of the load conditions and eliminates the risk of injury to the motor on account of faulty starting. The difficulties arising from too rapid acceleration on light load and too slow acceleration on heavy load, constitute a drawback to the use of the usual current limit systems where wide variations of load are experienced. The alternative method of starting by the time limit principle have hitherto involved the use of oil dashpots or other more or less complicated timing devices. In the inductive time limit controller the advantages of time limit acceleration are combined with absence of complication, acceleration of the motor being entirely independent of the operation of relays, dashpots, interlocks or other complicated moving parts which, the makers contend, always represent a possible source of breakdown. Owing, moreover, to the elimination of these parts inspection and maintenance costs are reduced. The inductive effect on which the operation of the new controller is based is obtained by means of a solid-core transformer situated in the lower part of the controller housing, the transformer having a number of independent shunt coils.

Each of the accelerating contactors on the control panel has a closing coil and a holding-out coil which tends to prevent the contactor closing. Each holding-out coil is connected to a transformer coil and acts as low resistance load. The control circuit connections are arranged so that the mutual inductance of the transformer coils controls the closing of the successive accelerating contactors by means of their respective holding-out coils, the operation resulting from the fact that since all the transformer coils are common to one magnetic core any change or reversal of the transformer flux gives rise to induced currents in the respective coils. These transient currents are utilised to produce the necessary time delay in the closing of the successive accelerating contactors, satisfactory operation being in no way dependent on the proper operation of small moving parts. Adjustment of the accelerating period to suit normal load conditions is made by varying the air gap between the holding-out magnet and the tail piece of the accelerating contactors, and after adjustment the air gap can be definitely set at the desired value in a simple manner. The control gear then operates so as to maintain the torque and accelerating currents at values corresponding to normal load conditions. With the same adjustment of the controller heavy peak loads and light loads are handled in an equally satisfactory manner. Peak loads within the capacity of the motor are accelerated safely, whilst if the load is excessive the motor is automatically disconnected from the supply by the action of overload time limit relays. The motor cannot, therefore, suffer damage as the result of stalling or excessive overload.

Owing to the fact that the starting inrush current and subsequent accelerating current peaks are limited to values proportional to the load on the machine, the system allows motors to be worked to the limits of their capacity. Overheating and consequent deterioration of the motor windings owing to excessive starting currents are avoided. Extreme flexibility is one of the outstanding features of the gear; there is immediate response to the operation of the master control switch, resulting in correct and uniform acceleration. The operator's work is consequently considerably simplified and skill in handling the gear is soon acquired. By reason of its simplicity and robust construction the inductive time limit controller is particularly suitable for heavy duty work and has already found a considerable field of application in steel works. The various items of the control gear are mounted on slate panels, which are enclosed in a steel structural housing, as shown in Fig. 28. There are two pairs of single-pole reversing contactors, one for each direction of rotation, and mechanical interlocks prevent both pairs of contactors being closed at the same time. A single-pole main contactor of similar construction serves for making and breaking the motor circuit and as it is connected with the opposite line to that in which the reversing contactors are connected, both sides of the motor are open circuited when the current is switched off. All these contactors are standard Igranic contactors as designed for steel mill service, and have renewable

FIG. 28—50 H.P. INDUCTIVE TIME LIMIT CONTROL —IGRANIC

solid copper contact tips of large section. They are protected by powerful blow-outs.

With the exception of the tail piece and holding-out magnet, the accelerating contactors are constructed on similar lines. All parts of these contactors, such as the contacts, springs, blow-outs and coils, are the same as those employed on the main and reversing contactors, and owing to standardisation of components the number of spare parts that must be carried for maintenance purposes is reduced to a minimum. The main and control circuits each have a double-pole knife isolating switch, and the connections are arranged so that with the control switch closed and the main switch open the operation of the controller can be tested without running the motor. The terminals for the control circuit are on a terminal board mounted in a convenient position on the back of the panel. With this controller a drum master control switch of special design and intended for frequent operation under arduous conditions of service is usually employed, the contact fingers being of "Igranic" non-stubbing construction with drop forged contact tips of ample size. They are mounted on insulated square steel shafts which can be completely removed from the case after slacking off two bolts. Moulded arc barriers give complete protection against flash-over. The drum cylinder consists of cast sections securely bolted to an insulated square shaft and carrying renewable contact segments of rolled bar copper. A removable cover plate allows the entire drum cylinder to be removed from the case for inspection or maintenance purposes. A star wheel engaging with a steel roller under spring pressure enables the operator distinctly to feel all the speed points.

Besides this new control panel the Igranic Electric Company will be exhibiting a three-phase time lag magnetic overload device with instantaneous phase failure protection, push button control stations for handling the control circuits of all types of A.C. or D.C. automatic starters and controllers, A.C. contactors, a plugging relay for the quick stopping of A.C. motors, and "Igranic" shoe brakes for A.C. and D.C. motors. Limitations of space will not allow us to deal with all these exhibits in detail. It must suffice briefly to consider the time lag magnetic overload device with instantaneous phase failure protection which incorporates instantaneous phase failure features with effective time lag overload protection. The relay will trip and open the pilot circuit on overloads occurring in three phases of more than 25 per cent. in excess of normal full-load current. An oil dashpot time lag gives a trip time in inverse proportion to the excess load. The maximum time at 25 per cent. excess current is two minutes, and it falls to fifteen seconds at 100 per cent. excess current. The time lag will permit of peaks during starting up to 500 per cent. inrush for one second. If any phase of the supply is open the relay will not permit the motor to start, and in the event of one of the phases failing while the motor is at work the independent "no-current" trip feature of the relay will immediately open the control circuit and stop the motor irrespective of the load on the machine. Not until all the phases are made active can the motor be re-started.

RANSOMES, SIMS AND JEFFERIES, LTD.

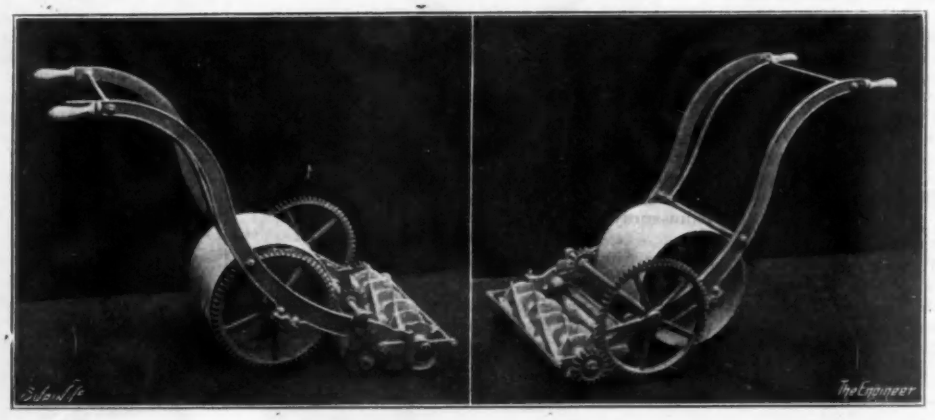
An interesting connection with engineering of two generations ago will be exhibited by Ransomes, Sims and Jefferies, of Ipswich. It is the lawn mower illustrated by Figs. 29 and 30, which is just 100 years old, and yet, it will be seen, has the same general outline as the machines of to-day. It is the first lawn mower produced, and was made at the Ipswich works in 1832.

Prior to the introduction of lawn mowers, grass was of course cut with a scythe, but it was a tedious process which required considerable skill, and to-day there are very few men who would attempt so to produce the smooth even surface which is required for sports purposes.

The idea of producing a mower to cut grass lawns appears to have first occurred to a Mr. Edwin Budding, of Stroud, Gloucestershire, who, in October, 1830, took out the first patent in this country for a machine of this character. Budding was employed by a Mr. Lister, father of the late Sir R. A. Lister, the founder of the well-known engineering works at Dursley. In his capacity as engineer in Mr. Lister's textile factory, Budding had charge of certain machinery, including a machine which was used for shearing the nap off cloth. Budding conceived the idea of using this principle in a machine for cutting grass, and in his original Patent Specification he says, "Country gentlemen will find in using my machine an amusing, useful, and healthful exercise."

Considering that his original machine was 19in. in width, and that the gearing was perhaps inferior to that which is now provided in the household mangle, it is an open question as to whether the exercise was as amusing as he imagined.

The main rollers of Budding's machine were very much larger than those used to-day. The gearing was cast and had very deep teeth, with very large pitch. The side frames and handles were in one casting and the wood rollers, which to-day are usually in front of the roller type machine, were placed between the back rolls and the cutting cylinder.



FIGS. 29 AND 30—A LAWN MOWER OF 100 YEARS AGO RANSOMES, SIMS AND JEFFERIES